A system for assessing passenger ride comfort highlights spinoffs in the field of transportation

In designing any kind of transportation vehicle, a major consideration is assuring that passengers get a smooth, comfortable ride. Until recently, that was difficult, due to the lack of a reliable and accurate method of measuring the "ride quality" of the vehicle being developed. Ride quality evaluations were based on the subjective judgments of individuals involved in system testing; this imprecise method often caused costly and time-consuming adjustments, sometimes requiring redesign and retooling, to get the desired level of ride comfort.

Last year, Wyle Laboratories, Hampton, Virginia, introduced to the commercial market an instrument that eases the job of the ride quality engineer, a portable Ride Quality Meter designed to measure the discomfort level of a vehicle passenger subjected to complex vibrations and noise. Produced under NASA license, the system is based on a prototype meter and computer model developed by Langley Research Center. Offering the first verifiable way of measuring ride quality, it is a design and diagnostic tool applicable to development of passenger cars, trucks, buses, trains, aircraft, spacecraft and a wide range of special purpose transportation systems.

The Langley ride comfort research program was an offspring of NASA studies, conducted more than a decade ago, of how new types of controls might contribute to smoother rides in passenger aircraft and surface vehicles. In the course of that research, it became apparent that there was a need for a mathematical model for estimating noise and vibration effects on passenger comfort and for the ultimate development of ride quality criteria.

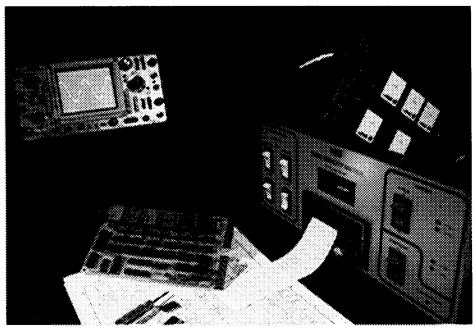
To develop such a model, Langley sought to determine human comfort responses to vehicle vibrations—in different frequencies and in different axes—and noise in various octave bands. Over a period of 10 years, more than 3,000 people served as test subjects in a Langley ride quality simulator. During exposure to controlled combinations of noise and vibration, each subject was asked to make evaluations detailing the level of discomfort experienced. These responses provided the basis for development of the computer model, which transforms individual noise/vibration elements into subjective units, then translates the subjective units into a single discomfort index that typifies passenger sensation of the total environment.

In order to acquire data in actual vehicle operations, Langley developed a prototype portable ride quality meter, which was designed by Wyle Laboratories under NASA contract. That development provided the technology for the Wyle Ride Quality Meter, which the company describes as "the most important advance in ride quality engineering to date."

Mounted on the vehicle to be evaluated, the Ride Quality Meter gets its vibration input from an external package of sensors and its noise input from a commercial sound level meter. About the size of a breadbox, the meter includes a computer and its Langley-

developed software, conditioning elements, a liquid crystal display and a printer. The conditioning elements filter, amplify and average the sensor-generated noise and vibration signals, which are computer processed to determine, display and print a set of discomfort indices representative of the subjective discomfort level produced by the noise and vibration. Among the printer outputs are: the total discomfort index; the vibration component of the total; the noise component; discomfort due to each of five axes of vibration; and discomfort due to individual noise bands. Thus, the meter serves as a "passenger jury" delivering a reliable and accurate verdict as to the ride quality of the vehicle being evaluated.

The system underwent extensive pre-production testing—by Langley/Wyle independently and in cooperation with vehicle manufacturers—and it performed well under a variety of ride conditions aboard helicopters, passenger cars, trucks, trains and surface effect ships. Since it represents the first known capability for summing the effects of noise and vibration into a single ride quality index, it has attracted considerable attention among government and industrial transportation interests; some of the nation's major manufacturers of transportation equipment—including Ford Motor Company, Firestone Tire and Rubber Company and International Harvester—were among the initial customers. ▲



In the upper photos, a technician is using a Wyle Laboratories Ride Quality Meter to assess the level of comfort experienced by passengers in vehicles of the Baltimore Metro system. Shown in closeup above, the Ride Quality Meter includes noise and vibration sensors and a computerized meter that processes the sensor-generated data, then displays and prints a ride quality reading.